PRODUCT OVERVIEW MBR

water | wastewater | treatment | recycling

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makwater.com.au

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Overview

MAK Water's Membrane Bioreactor (MBR) waste water treatment plants are designed to treat domestic strength sewage, to achieve Class A+ treated effluent, suitable for reuse in virtually all non-potable "risk category high" applications.

MAK Water's MBR plants are containerised systems for easy deployment to remote locations.

MAK Containerised 200 m^3/day MBR Plant

The MAK Advantage:

- High quality Australian designed and built systems
- Proven design, approved by Department of Health (WA)
- Containerised system minimises site installation work
- Factory tested prior to delivery
- Nationwide service & maintenance capabilities
- Remote monitoring for expert process support
- Fully automated systems minimise operator attendance
- MAK standard designs for fast lead times
- Optimised designs to suit client's objectives
- Fully customisable to accommodate client specific engineering standards, vendor data requirements and site preferred electrical equipment
- Extensive hire fleet available for rapid deployment

MAK Containerised 2 x 250 m^3/day MBR Plant

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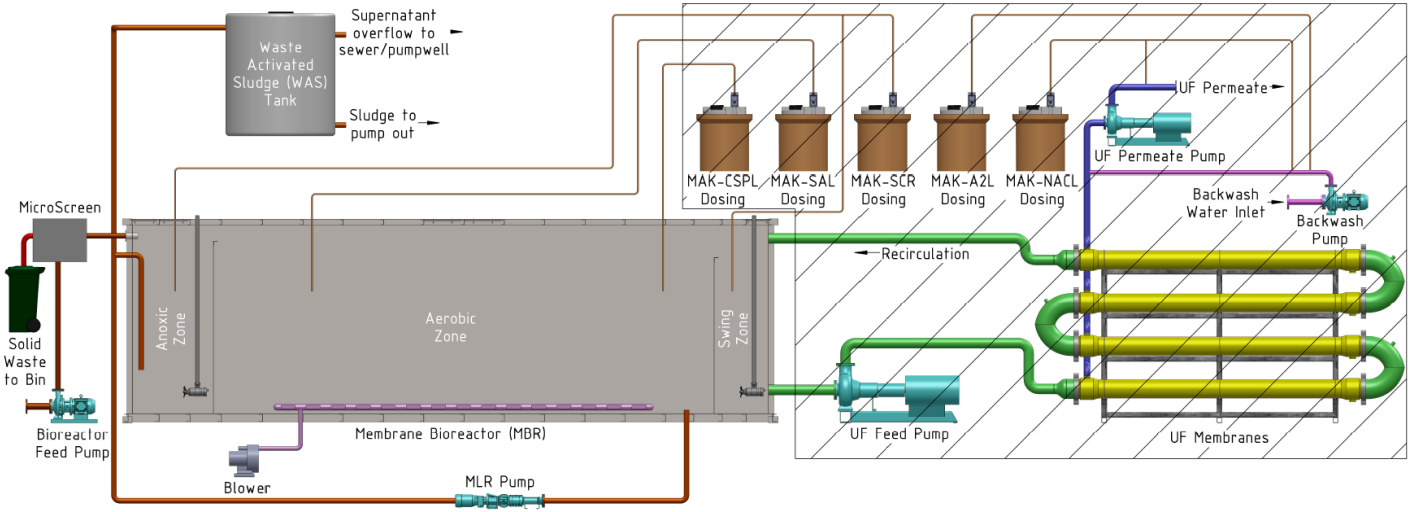
Overview



The MBR process is a suspended growth activated sludge system that utilises microporous membranes for solid/liquid separation in lieu of secondary clarifiers.

The standard treatment process involves influent screening, biological degradation (anoxic/aerobic treatment), cross flow ultrafiltration (UF) pressure membranes (external to the bioreactor), with automated chemical cleaning system, and effluent sterilization (chlorination).

Additional treatment steps for enhanced nutrient removal (T-N & T-P), secondary effluent sterilization (UV or residual trim hypo dosing), and sludge de-watering systems may be added as required to suit influent quality and/or treated effluent quality requirements.

The pretested, compact nature of the containerised design minimises site installation works and enables plug and play operation.

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Overview

The following table summarises typical influent and treated effluent values.

Parameter	Unit	Influent	Effluent (Class A+)
BOD	mg/L	150~500	<10
TSS	mg/L	150~400	<10
T-N	mg/L	<50 (<80 with ENR)	<40 (<10 with ENR)
T-P	mg/L	<15	<10 (<3 with ENR)
Turbidity	NTU	-	<2
E.Coli	CFU/100 mL	-	<1
Coliphages	PFU/100 mL	-	<1
Clostridia	CFU/100 mL	-	<1
Free Chlorine	mg/L	-	0.2~2

NOTES:

- MAK Water recommends an influent analysis be carried out prior to detailed design, if possible
- ENR = Enhanced Nutrient Removal (optional)

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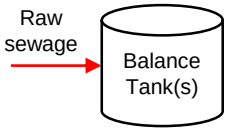
Process Steps



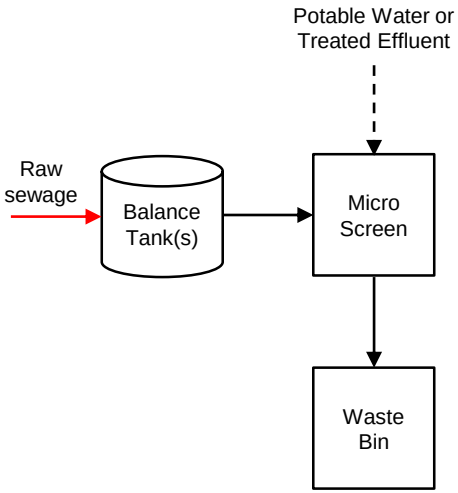
Balance Tank

The Balance Tank is designed to handle peak flows and allow a pre-determined and controlled flow for subsequent treatment. The waste water is temporarily stored in the Balance Tank before being pumped to the inlet (micron) screen located above the MBR's bioreactor. The feed pump flow rate is set using a flow control valve; excess flow is returned to the balance tank to maintain homogeneity of influent feed.

The Balance Tank level is regulated by 3 float-type level switches.

The feed pump flow rate is continuously monitored; an alarm is generated by any abnormal readings.

Process Steps



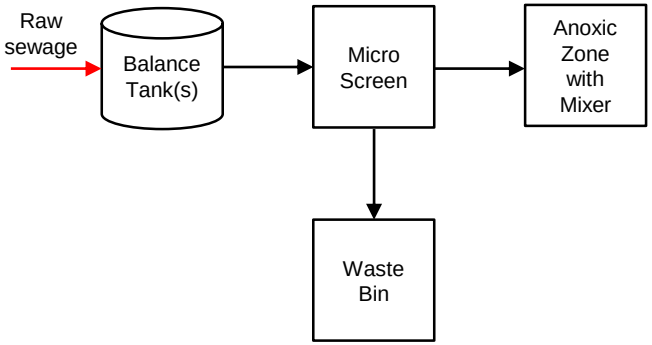
Micro Screening

The raw sewage is pumped from the balance tank to the inlet (micron) screen. The micro screen is a disc filter comprising a 250 micron filtering mesh with a self-cleaning system using pressurised water (or treated effluent); it is ideally suited for MBR pre-screening applications, thanks to the ability to trap hairs and fibres, which, if not removed, have the potential to foul the UF membranes downstream.

Particles are retained in the mesh; when the pre-set pressure differential is reached, the washing cycle begins. While the discs slowly turn, water jets send water towards the mesh, dragging the solids to a hopper situated in the centre part of the equipment.

Screenings are deposited into a waste receptacle; screened effluent discharges into the bioreactor's anoxic tank for treatment.

Process Steps



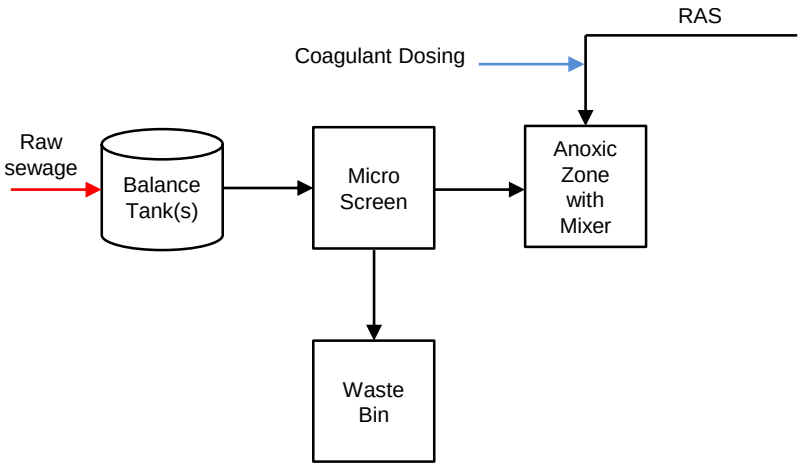
Anoxic Tank

The screened sewage from the micro screen flows into the Anoxic Tank, which allows nitrate-specific bacteria to use nitrate (NO_3) as an oxygen source and a nutrient in a process called denitrification.

De-nitrification occurs when oxygen levels are depleted and nitrate becomes the primary oxygen source for microorganisms. The process is performed under anoxic conditions, when the dissolved oxygen concentration is less than 0.5 mg/L, ideally less than 0.2 mg/L. When bacteria break apart nitrate (NO^{3-}) to gain the oxygen (O_2), the nitrate is reduced to nitrous oxide (N_2O), and turns to nitrogen gas (N_2). Since nitrogen gas has low water solubility, it escapes into the atmosphere as gas bubbles. Free nitrogen is the major component of air, thus its release does not cause any environmental concern.

The tank is fitted with a submersible mixer, with guide rail and lifting chain for maintenance.

Process Steps



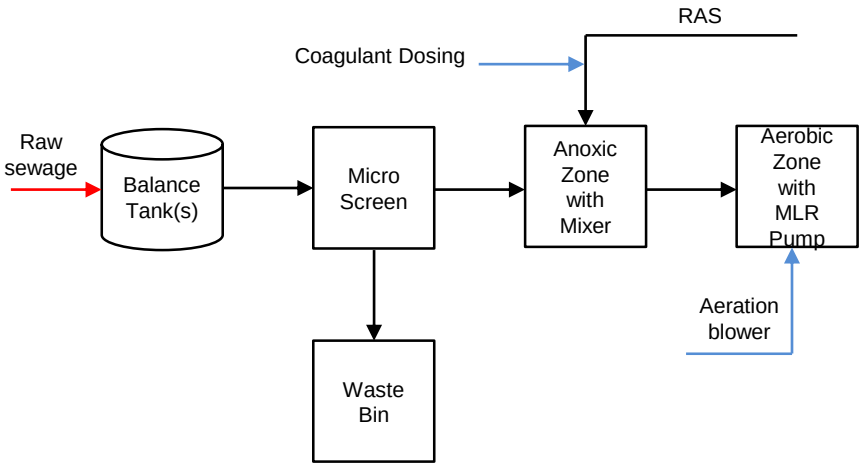
Anoxic Tank

The anoxic tank is enriched with returned activated sludge (RAS) from the Aerobic Tank's MLR pump, to provide a plentiful supply of food for the bacteria

Coagulant is used to react with orthophosphates to form phosphate precipitates. This reaction is very rapid. The coagulant will also react with the alkalinity in the wastewater to form water insoluble hydroxides. These insoluble salts will deposit onto the sludge particles, which are removed from the treatment system with the excess sludge (WAS).

Where ClearAccess^{TM} remote monitoring is installed, the ORP is continuously monitored; an alarm is generated by any abnormal readings.

Process Steps



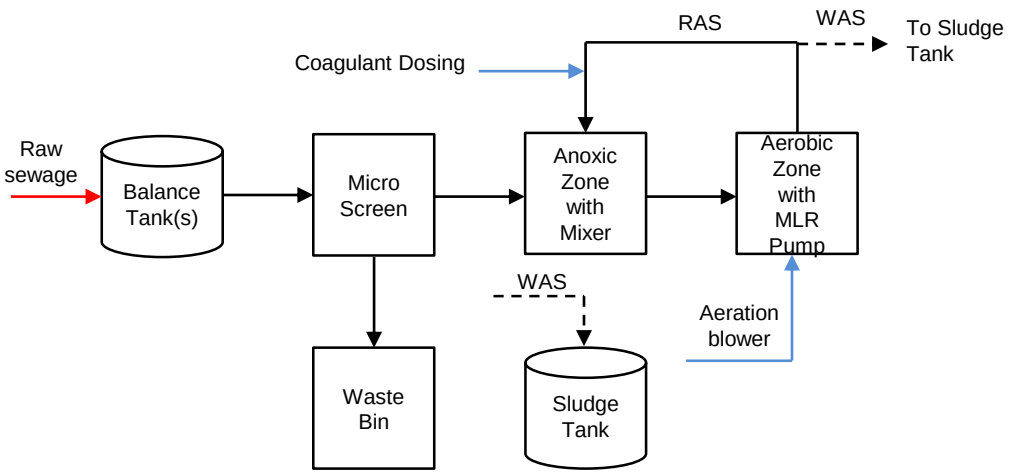
Aerobic Tank

BOD removal and nitrification occurs in the aerobic zone. Wastewater overflows from the anoxic zone to the aerobic zone. Air is introduced into the aerobic zone through fine bubble diffusers, located on the tank floor, by the dedicated aeration blower.

The autotrophic bacteria oxidize inorganic nitrogen components to obtain energy for growth and maintenance, while they remove a majority of the colloidal contaminants present in the waste water by converting them into carbon dioxide and biological floc.

Nitrification is a two-step process. Bacteria known as Nitrosomonas convert ammonia and ammonium to nitrite. Next, bacteria called Nitrobacter finish the conversion of nitrite to nitrate.

Process Steps



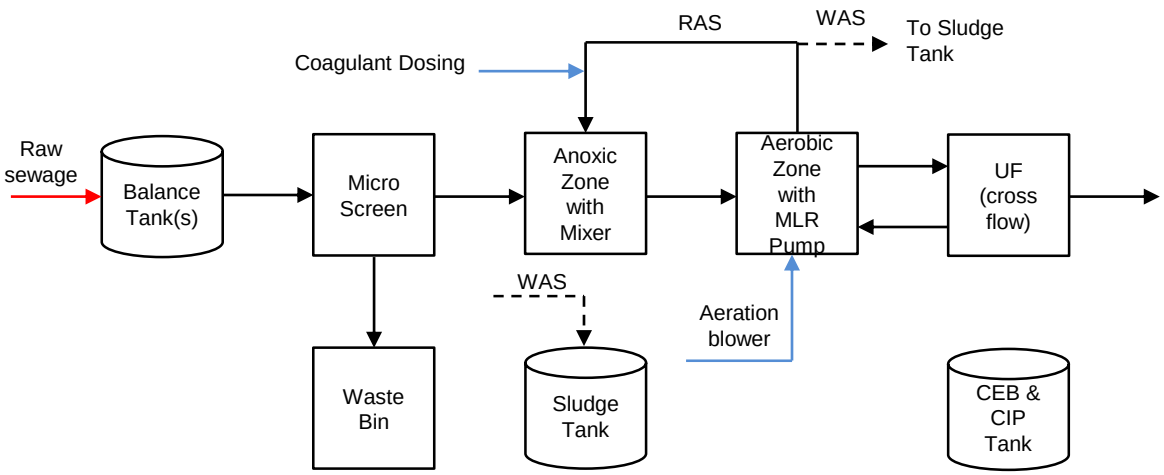
Aerobic Tank

On a continuous basis, the Mixed Liquor Return (MLR) pump recirculates the Mixed Liquor Suspended Solids (MLSS) around the bioreactor. A certain portion of activated sludge is periodically removed or "wasted" from the biological system in order to maintain a pre-selected sludge age in the Biological Tanks. Activated bio-solids (sludge) are transferred through the dedicated Waste Activated Sludge (WAS) pipeline to the sludge tank.

The aerobic tank level, RAS and WAS flow rates are continuously monitored; alarms are generated by any abnormal readings.

Where ClearAccess™ remote monitoring is installed, a Dissolved Oxygen (DO) analyser continuously monitors the oxygen level, with the PLC automatically controlling the speed of the blower.

Process Steps



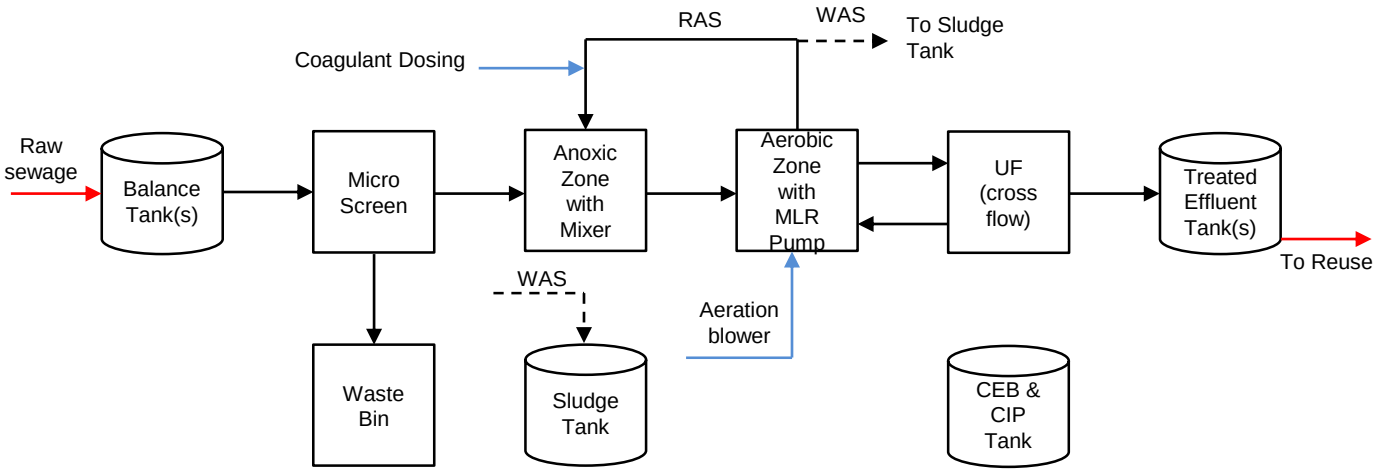
Ultra Filtration

MAK Water's MBR plants utilise Berghof Biopulse technology, which makes use of the unique feature of the HyMem 8 mm PVDF LE (Low Energy) membrane: it can be backwashed.

Mixed Liquor Suspended Solid (MLSS) from the bioreactor is pumped, at an optimized flow rate, through the externally mounted cross flow Ultra Filtration (UF) membranes, which separate the bio-solids from the liquid by means of filtration.

The cross-flow filtration method creates turbulence on the membrane surface, thereby hindering the accumulation of retained particles. A high flow speed at the membrane surface carries the particles back into the main flow, thereby minimizing the formation of the coating layer.

Process Steps



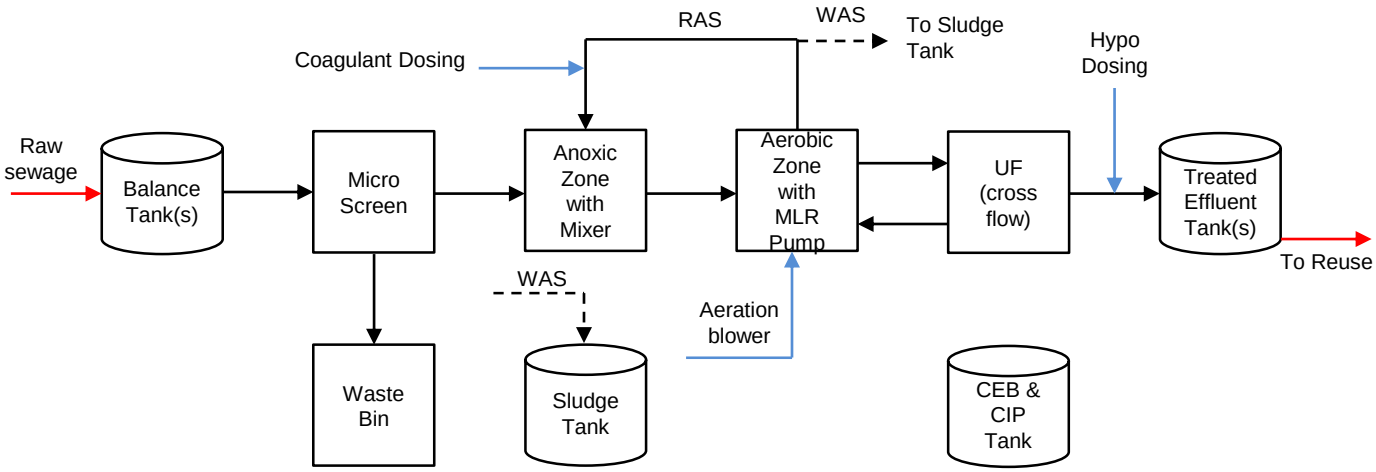
Ultra Filtration

The clear filtrate, free of bacteria, viruses and solids, is deposited into the treated effluent tank. The concentrate is returned back into the bioreactor.

The membrane feed pressure, concentrate pressure & flow and filtrate pressure & flow are continuously monitored; alarms are generated by any abnormal readings.

Where ClearAccess™ remote monitoring is installed, the filtrate pH, free chlorine and turbidity are continuously monitored; alarms are generated by any abnormal readings.

Process Steps

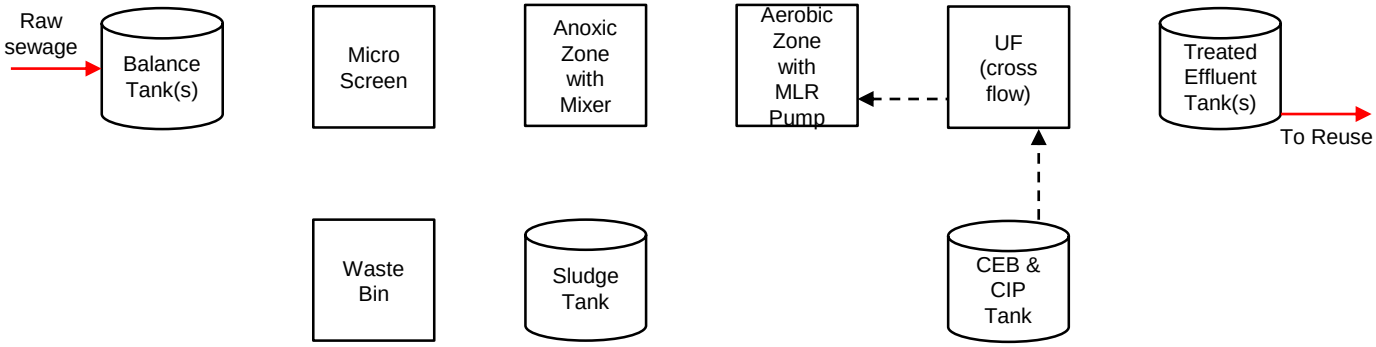


Flow Paced Hypochlorite Dosing

UF filtrate is dosed with sodium hypochlorite to maintain a sterile environment. The dose rate is set based on the filtrate flow rate to achieve the desired free chlorine concentration in the effluent.

The hypochlorite and coagulant storage tanks are fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the tank levels should be checked regularly and topped up as required.

Process Steps



Ultra Filtration – Auto Backwashing

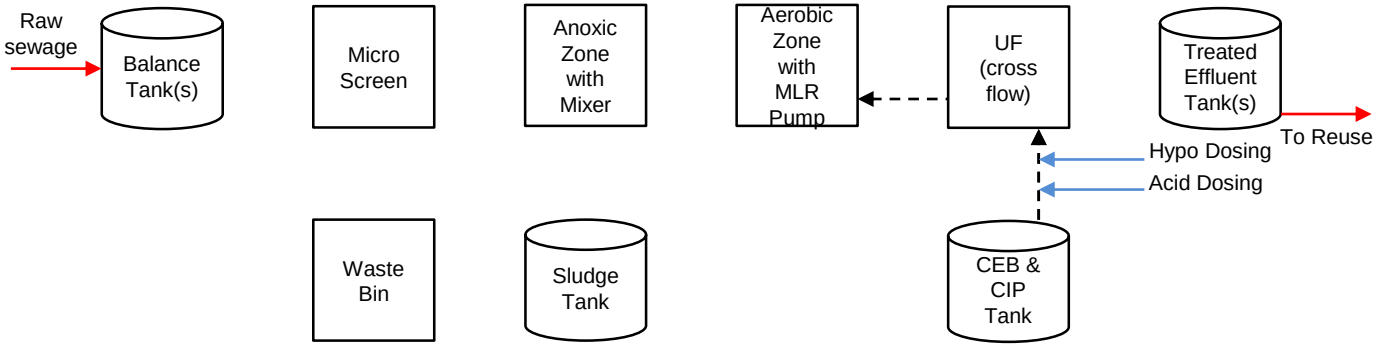
An integrated automatic backwashing program controls the backwash cycles and backwash time in order to ensure reliable operation.

The UF backwash pump takes suction from the CEB/CIP tank, which contains UF filtrate.

During normal filtration sequence, individual UF modules are automatically backwashed at a defined frequency triggered by timer; backwashing can also be manually initiated via the HMI touch-screen.

The backwash pump discharge pressure & flow are continuously monitored; alarms are generated by any abnormal readings.

Process Steps



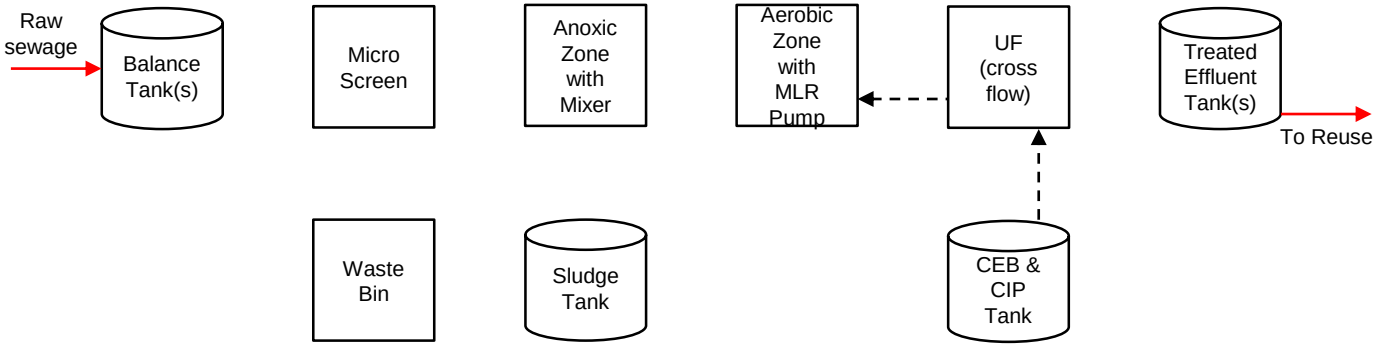
Ultra Filtration – Auto Chemically Enhanced Backwashing

In addition to regular backwashing, a Chemically Enhanced Backwash (CEB), whereby dosing systems are used to add chemicals (acid and hypochlorite) during the backwashing process, is carried out on a periodic basis.

Backwashing and CEB processes are fully automated and require no operator intervention.

The hypochlorite and acid storage tanks are fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the tank levels should be checked regularly and topped up as required.

Process Steps



Ultra Filtration – Auto Flushing

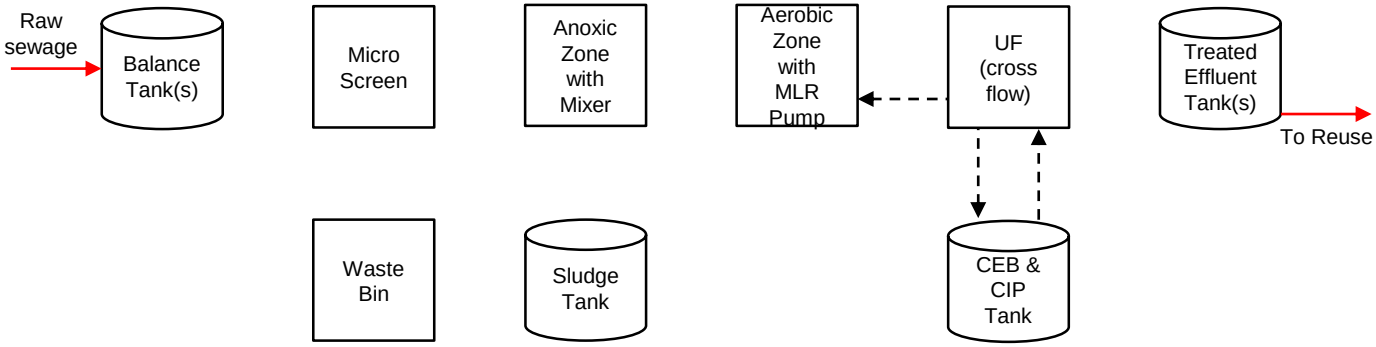
The UF circulation pump takes suction from the CEB/CIP tank, which contains UF filtrate.

In case of plant shutdown, or if the trans-membrane pressure (TMP) exceeds the set point, the membranes are automatically flushed with treated effluent from the CEB/CIP tank to avoid harmful sedimentation and clogging of the membranes.

The PLC will initiate the flushing sequence and will raise an alarm.

The CEB/CIP tank is fitted with a low level switch for auto-shutdown on low level condition

Process Steps



Ultra Filtration – CIP

A Clean In Place (CIP) system is provided for routine chemical cleaning of the UF membranes; the chemical clean is a manually initiated function requiring an operator, whereby acid/alkaline chemicals are manually added to the CEB/CIP tank and circulated around the membranes for a period of time. Spent CIP solution is returned to the bioreactor.

A CIP membrane clean is typically performed on a semi-annual basis as part of a routine planned maintenance procedure.

Options – ClearAccess™

Optional ClearAccess™ Remote Monitoring enables personnel to view and operate the plant remotely. This saves time in response to emergencies and assists local operators to diagnose problems. It prevents unnecessary service call-outs and improves reliability and plant uptime.

Process Support via ClearAccess™

Key Functionality:

- Remotely view and operate the plant on your PC, smart phone or tablet
- Automatic alerts (email or SMS) on alarm conditions
- Automatic report generated daily and emailed to your inbox
- Real time monitoring of process data, such as flow rates, pressure and alarm conditions/status messages
- Password protected system with two login security levels

ClearAccess™ from your Smart Phone or Tablet

Inclusions:

- Additional electrical instrumentation (premium package)
- Additional PLC hardware and programming
- Programming of email alert system

NOTE: Remote monitoring requires an internet connection or mobile network coverage (client to provide SIM card).

Options – Containerised UF Plant

The UF system (including chemical dosing and PLC controls) can be installed in ISO sea container(s) for safe, fast deployment by sea, road and rail. Installing the UF system inside sea container(s) is an ideal way to protect the plant and equipment from harsh operating conditions in remote sites. The durable construction assures the plant is able to be transported through rough terrain and perform to the design requirements on arrival at remote sites (plug and play operation).

Standard Container

Premium Fit Out (insulation, floor coating and access door)

Standard UF Container Inclusions:

- As new, freshly painted inside and out (high gloss enamel)
- Distribution board with separate circuits for lights & aircon
- Overhead internal lighting & reverse cycle air conditioning
- GPO's for maintenance work

Premium UF Container Fit Out Options:

- Chemically resistant, non-slip floor coverings
- Wall and ceiling insulation
- Personal access doors & windows
- Smoke detectors and alarming
- Safety shower & eyewash station with flow switch & lighting
- High spec/high build two-pack epoxy container painting

Containerised UF & Chemical Dosing Systems, with chemically resistant, non-slip floor coverings

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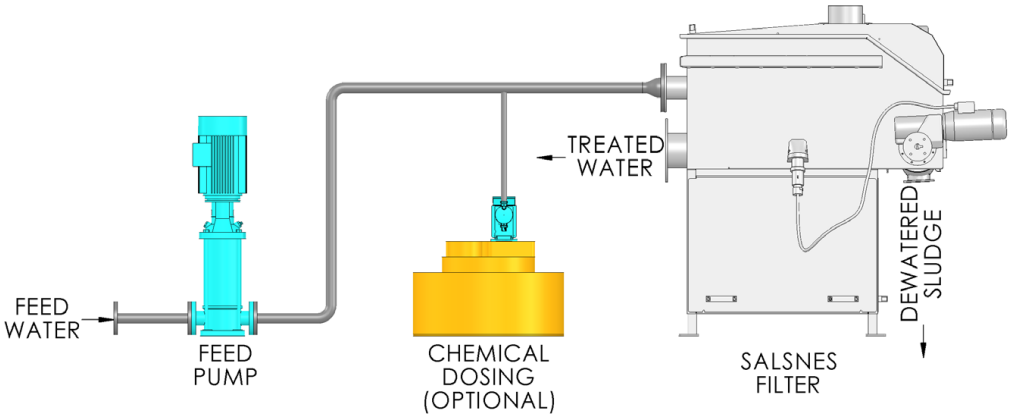
Options – Salsnes Fine Screen Filter

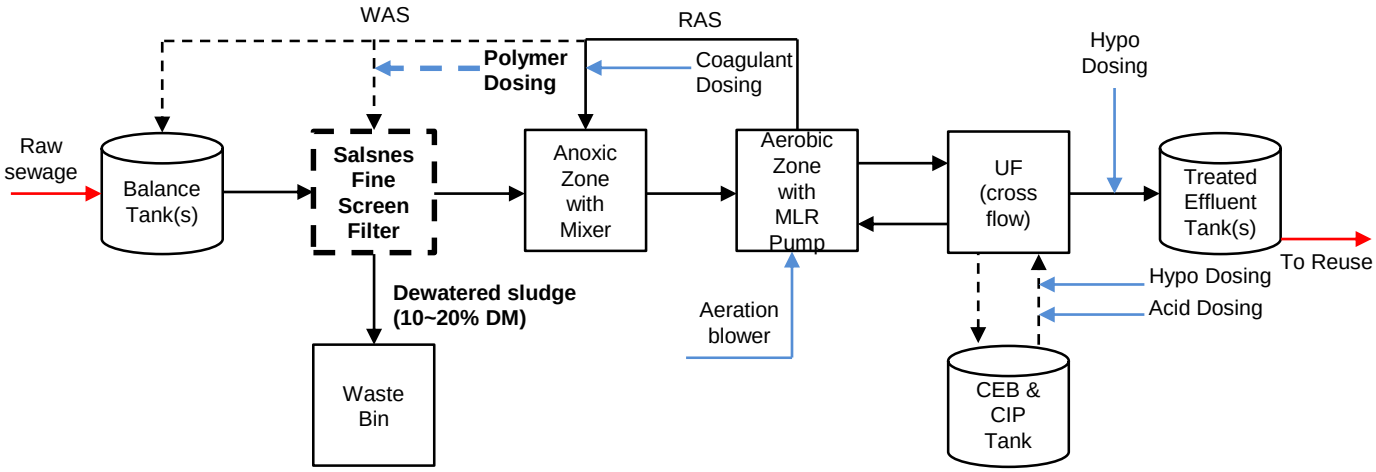


The Salsnes Filter system can use used as a replacement for the Micro Screen, and provides a significant advantage: the ability to dewater the sludge (10~20% dry matter) and thereby reduce operating costs by eliminating the handling of sludge.

Three critical processes, solids separation, primary sludge thickening and dewatering are performed in one compact unit that can completely replace conventional primary treatment and does so in a fraction of the footprint, saving costs and valuable land space.

It does this by building a filter mat, particles larger than the mesh opening start the process by partially blocking the mesh. This in turn traps smaller and smaller particles building the mat. Solids are gently lifted from the effluent for thickening and dewatering. The unique air knife technology continually cleans the mesh, continually presenting clean mesh to the effluent.

Options – Salsnes Fine Screen Filter



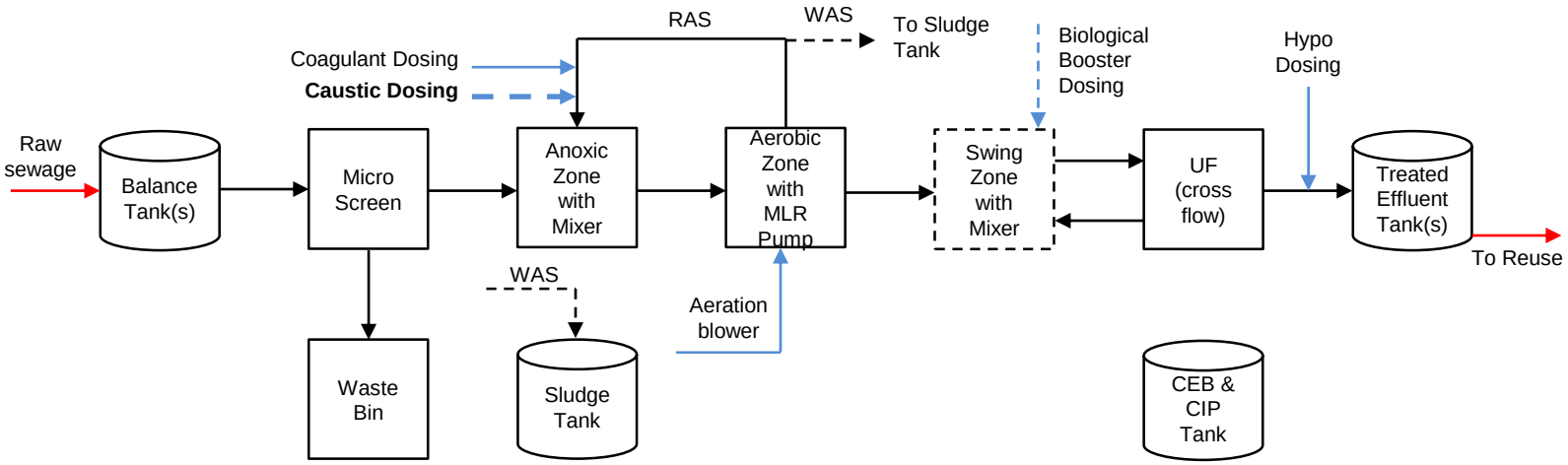
Salsnes Fine Screen Filter

The fine screen filter performs three critical processes – solids separation (fine screening), sludge thickening and sludge dewatering – all in one compact unit: removing >10% TSS, >10% BOD and producing dewatered sludge (10~20% dry matter).

The fine screen filter is mounted on a platform above of the bioreactor. The screen filter receives macerated sewage and/or waste activated sludge from the feed pumps and discharges screened sewage into the bioreactor.

To assist the formation of sludge cake, polymer is dosed into the WAS Line. The dewatered sludge cake (10~20% dry matter) is deposited into a waste receptacle for disposal. Thanks to the fine screen filter, a sludge storage tank is not required.

Options – Enhanced Nutrient Removal



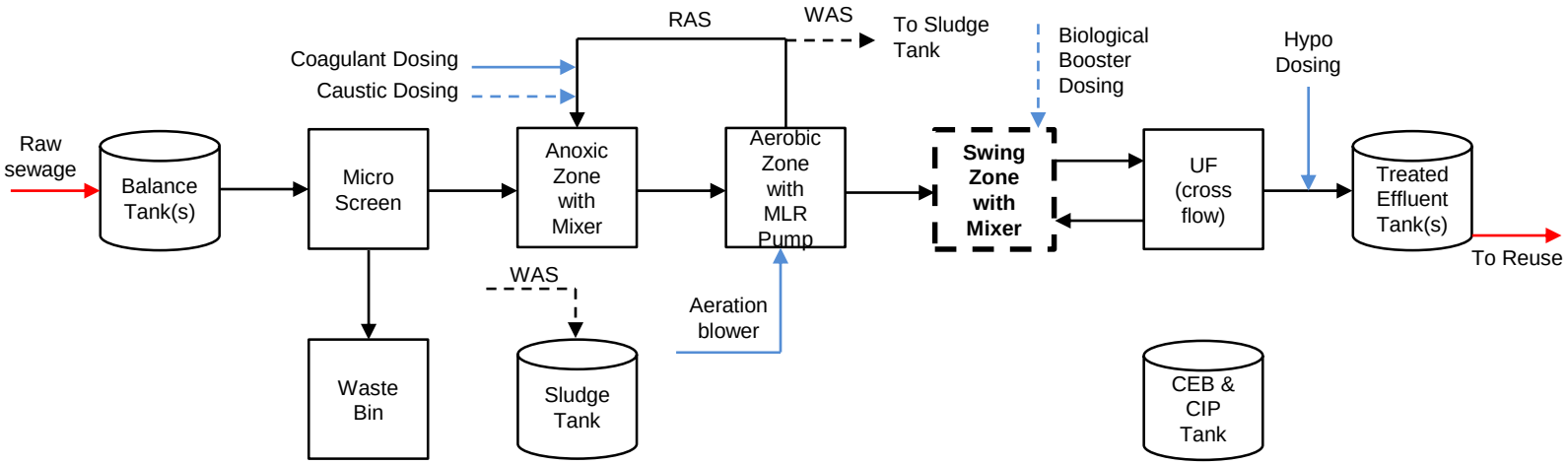
Enhanced Nutrient Removal – Caustic Dosing

The nitrification process produces acid. This acid formation lowers the pH of the biological population in the aeration tank and can cause a reduction of the growth rate of nitrifying bacteria.

Where the Enhanced Nutrient Removal option is installed, caustic is dosed into RAS line to add alkalinity to the activated sludge. A pH analyser inside the aerobic tank monitors the pH, and the PLC controls the dosing of caustic as required to ensure adequate alkalinity is maintained. Alarms are generated by any abnormal readings.

The caustic storage tank is fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the tank level should be checked regularly and topped up as required.

Options – Enhanced Nutrient Removal



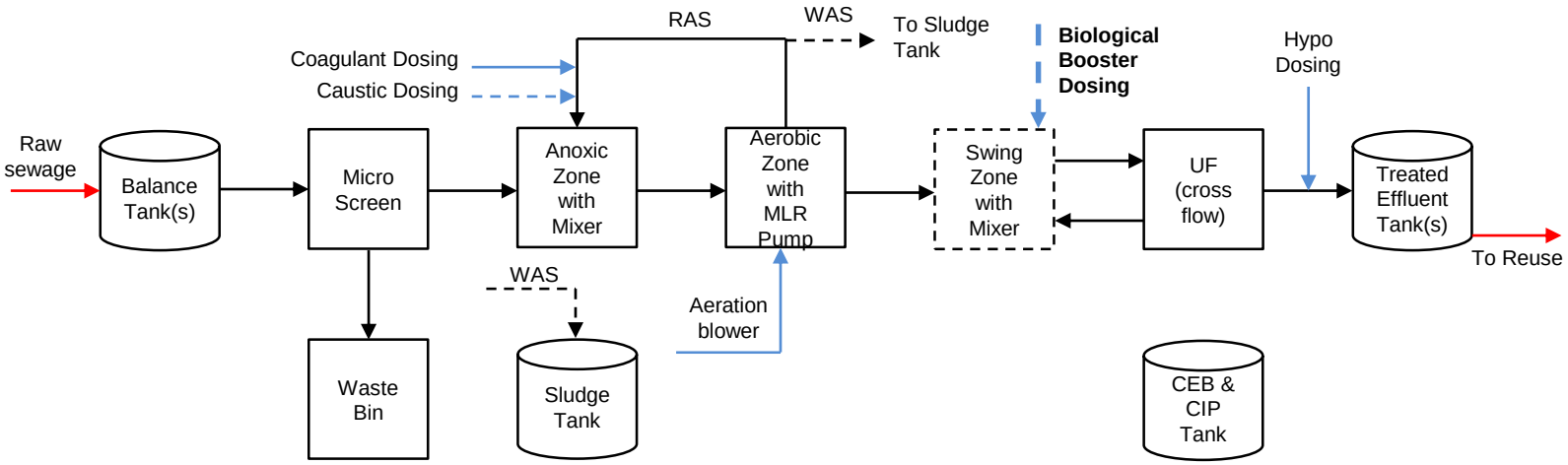
Enhanced Nutrient Removal – Swing Zone

Where the Enhanced Nutrient Removal option is installed, a swing zone is provided. This zone operates as anoxic to enhance de-nitrification. Wastewater overflows from the aerobic zone to the swing zone. The tank is fitted with a submersible mixing pump, with guide rail and lifting chain for maintenance.

The ORP in the swing zone is continuously monitored; an alarm is generated by any abnormal readings.

NOTE: The swing zone can also be operated as “aerobic zone 2”, to enhance nitrification under certain conditions, such as low temperature or peak loading. This zone can operate at low DO set-point to promote simultaneous nitrification and de-nitrification.

Options – Enhanced Nutrient Removal



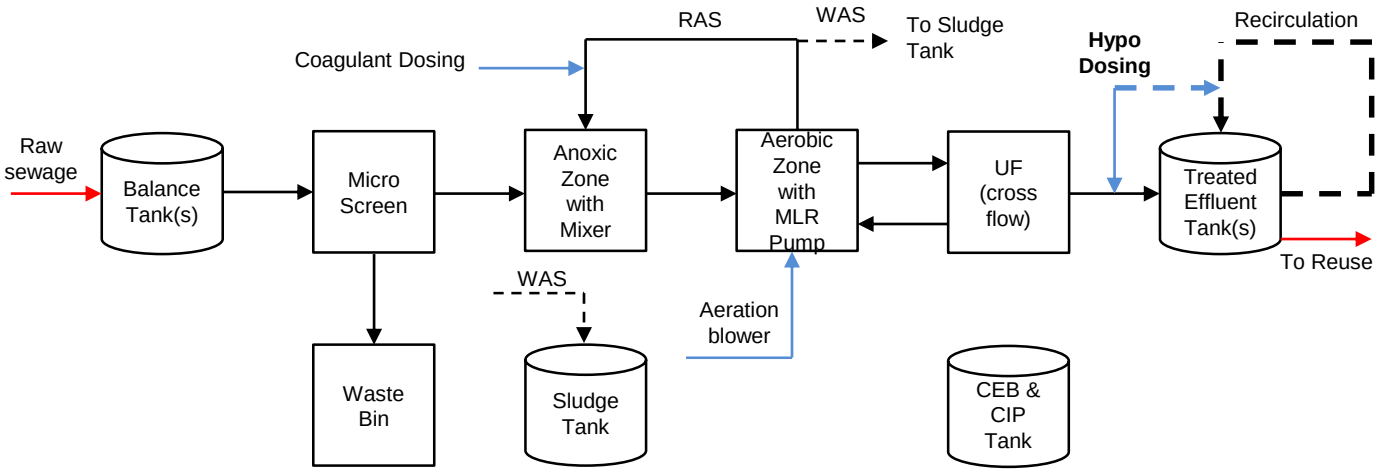
Enhanced Nutrient Removal – Biological Booster Dosing

Where the Enhanced Nutrient Removal option is installed, an external carbon source is required to overcome a high ratio between influent nitrogen and influent BOD.

A biological booster agent (carbon source) is dosed into swing zone to supply food/COD for microbiology growth.

The biological booster storage tank is fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the tank level should be checked regularly and topped up as required.

Options – Effluent Sterilisation

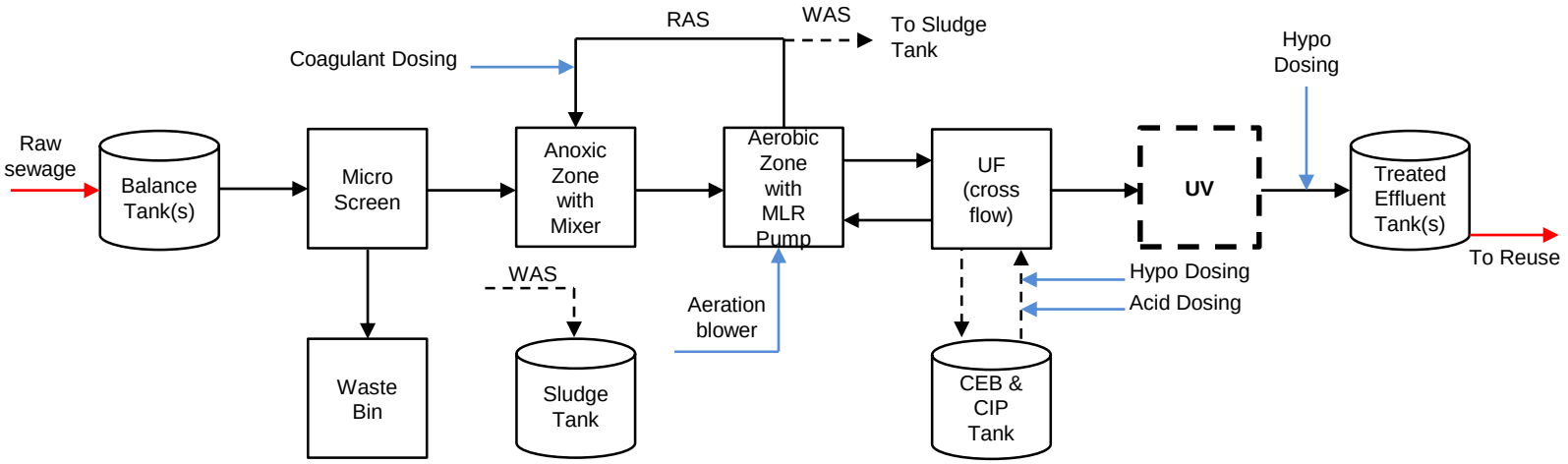


PLC Controlled (Residual Trim) Hypochlorite Dosing, with Recirculation & Monitoring

The recirculation pump circulates the contents of the effluent storage tank on a continuous basis; a chlorine analyser monitors the free residual chlorine, and the PLC controls dosing of sodium hypochlorite as required to ensure correct free chlorine levels are maintained in the tank at all times. Alarms are generated by any abnormal readings.

The hypochlorite storage tank is fitted with a low level switch for auto-shutdown and to alert the operator of a low level condition; the tank level should be checked regularly and topped up as required.

Options – Effluent Sterilisation



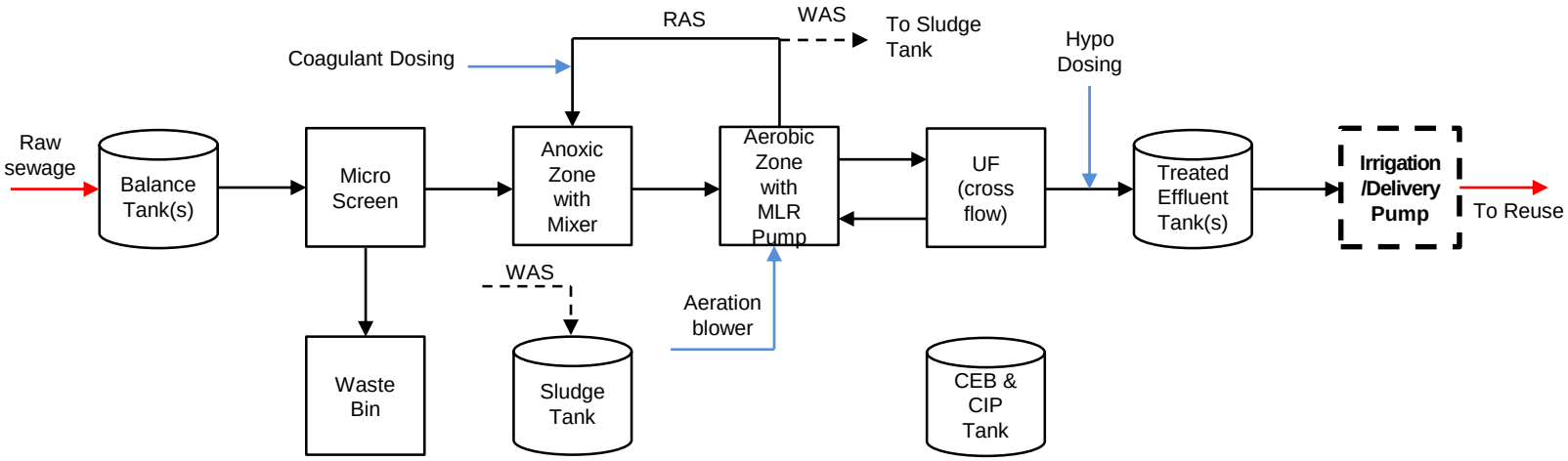
UV Sterilisation

It is sometimes preferable to use a UV steriliser as a replacement for hypochlorite dosing (e.g. where discharge is to environmentally sensitive waterways), or as a supplement to hypochlorite dosing.

The UF permeate passes through the UV steriliser, which delivers a massive dose of UV radiation, ensuring effective eradication viruses and pathogens. The on-board UV intensity monitor continuously monitors the UV intensity; an alarm is generated if the UV intensity drops below the minimum requited dose rate.

Pre-validated UV systems are available on request.

Options – Irrigation/Delivery Pump



Irrigation/Delivery Pump Set

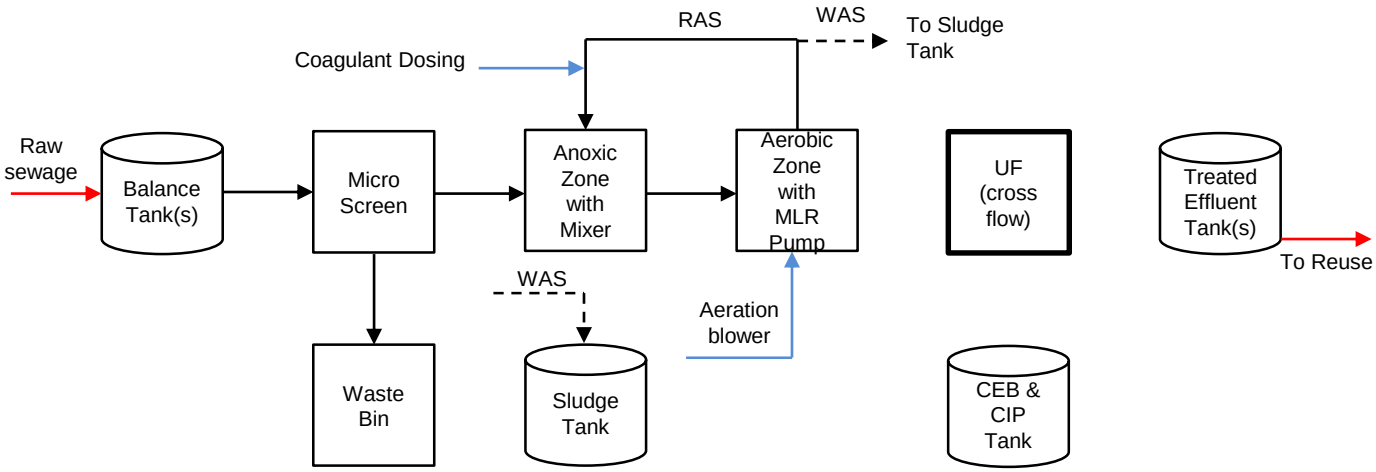
A treated effluent delivery pump set can be provided to deliver treated water to end users.

The system typically is configured as a constant pressure system, with the capability to deliver variable flow rates in response to downstream demand.

A pressure sensor is installed on the discharge manifold to automatically control the operation of the pump.

Various options are available for pumping configurations (VSDs, standby pumps etc), and electrical controls, to suit the client's requirements.

Options – Membrane Integrity Testing



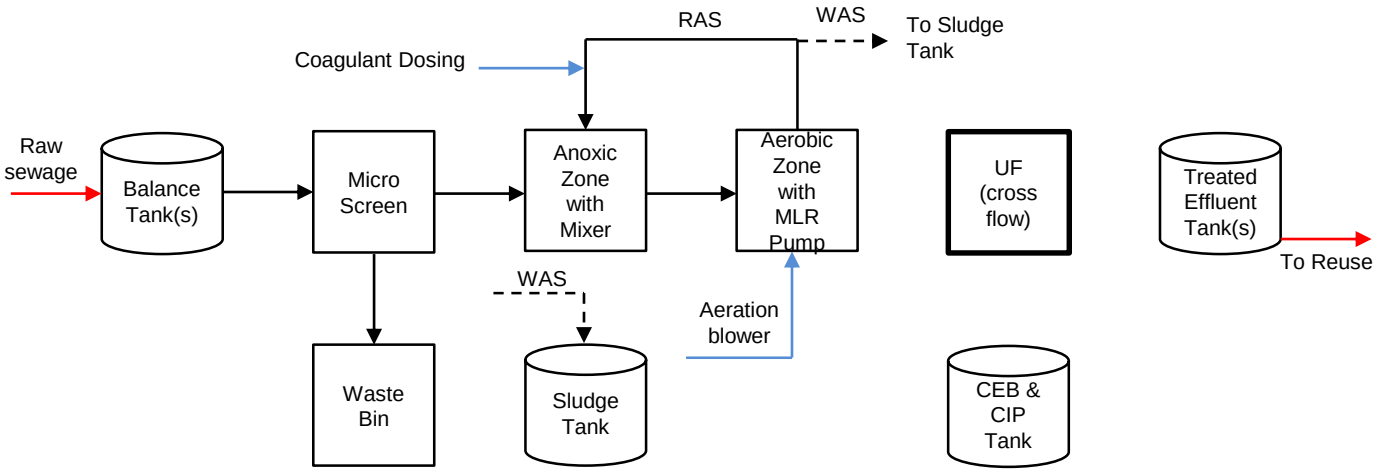
Automated Membrane Integrity Testing

An automated pressure decay test can be incorporated to determine the integrity of the UF membranes.

The theory behind the pressure decay test is based upon the bubble point principle, which states that the pressure required to force an air bubble through a pore is inversely proportional to the size of the pore. This means that low pressure air should not pass a wetted UF membrane.

The concentrate side is drained and pressurised as the permeate side is left open to atmosphere. A broken fibre will allow a rapid escape of the pressurised air. This air can be seen, as a clear piece of pipe is included in the permeate line leaving each UF module.

Options – Membrane Integrity Testing



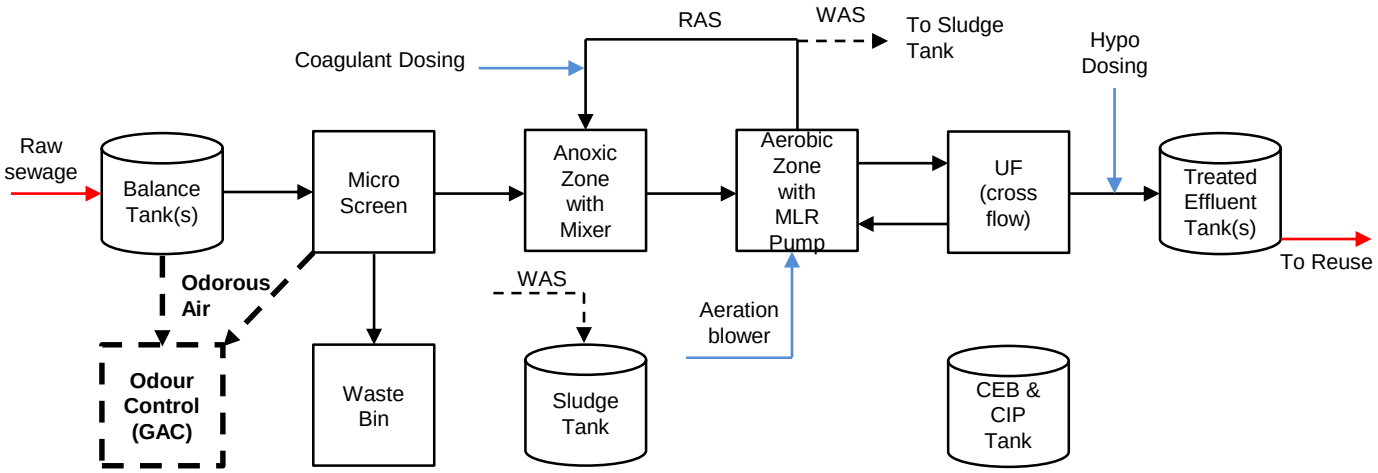
Automated Membrane Integrity Testing

When the Membrane Integrity Test (MIT) is initiated, the MIT valve opens, allowing air into the feed end of the UF modules, and the permeate valve opens. All other valves are closed. During this time, water is completely purged from inside the fibres and the air pressure is allowed to stabilise at the test start pressure.

After the test pressure has stabilised, the MIT valve closes and the test pressure is monitored. If broken fibres are present, the decay rate will be faster than acceptable and the system will alarm.

The automated air pressure hold and air leak tests, in conjunction with on-line turbidity monitoring, are effective means of ensuring membrane integrity.

Options – Odour Control



Odour Control

An odour control system can be provided for scrubbing of odorous air streams from the balance tank(s) and the micro screen filter.

The system includes an extraction fan and activated carbon canisters. The canisters are readily interchangeable and replaceable.

Understanding Reuse

The guidelines for the non-potable uses of recycled water seek to encourage beneficial and sustainable use of recycled water and provide guidance for planning, design, approval, operation and monitoring of recycled water supplies in regards to safeguarding public health and the environment.

Treated wastewater need not be considered a “waste” product to be discarded but a resource that can have potential value if treated to a level that is ‘fit for purpose’, that is, recycled water must be treated to a level that is suitable for its end use.

The level of treatment and monitoring that is required depends on the final application of the recycled water. End uses have been split into 4 levels of ‘Exposure Risk’:

High	Requires the highest quality of end use water and rigorous barriers, safeguards and monitoring regimes
Medium	Has moderate risk, usually reduced from a high risk category through barriers and safeguards
Low	Presents a low risk to human health (minimal contact)
Extra Low	Negligible risk

Understanding Reuse

The MAK MBR WWTP produces treated effluent in compliance with “Risk Category High” of the guidelines; the treated effluent is suitable for reuse in low, medium and high risk reuse applications.

Some “Low, Medium & High Risk” reuse applications include:

Exposure Risk Level	Potential End Uses
High (Class A+)	Multi dwellings; internal reuse (toilet flushing and dedicated cold water taps for washing machines) or external surface irrigation Agricultural irrigation of food crops consumed raw or unprocessed Urban surface irrigation with unrestricted access and application Fire fighting
Medium (Class A)	Dust suppression Wash down water Cooling towers Industrial use with potential human exposure Urban surface irrigation with some restricted access and application Fountains and water features Stock watering, dairy cattle, grazing Commercial food crops
Low (Class C)	Urban irrigation with enhanced restricted access and application* Communal residential irrigation (sub-surface for fruit trees) Agricultural irrigation; non-edible crops, fodder livestock Subsoil irrigation

NOTE: The relevant health authorities may require an approved Recycled Water Quality Management Plan to be in place, prior to authorising reuse of the treated effluent. MAK Water can provide this.

Clearmake
a mak water company

Projects Experience

Project	Exxon Mobil PNG LNG Project
Location	Port Moresby, PNG
Date	2015
Scope	Design & construct, installation assistance, commissioning & operator training, remote monitoring + service & maintenance
Capacity	2 x 250 m^3/day
Influent	Domestic Strength Sewage
Treated Water	Class A+ for risk category high reuse
Features	Containerised solution with 2 x 50% treatment trains and duty/standby dosing pumps Ultra high quality effluent External pressurised UF membranes Two step sterilisation with UV + Hypo Dosing Automated membrane integrity testing Sludge drying to >70% dry mater Odour control system 20 Year Mechanical/Electrical Design Life

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Projects Experience

Project	Karratha Airport Hydraulic Upgrade
Location	Karratha, WA
Date	2012
Scope	Design & construct, commissioning & operator training, 5 year Operate & Maintain contract
Capacity	200 m^3/day
Influent	Sewage, high TN/TP
Treated Water	Class A+ for risk category high reuse
Features	40' Containerised plant Fully automated plant, including membrane cleaning systems Ultra high quality effluent External pressurised UF membranes ClearAccess™ Remote Monitoring & Control MAK Standard (Data Sheet Product)

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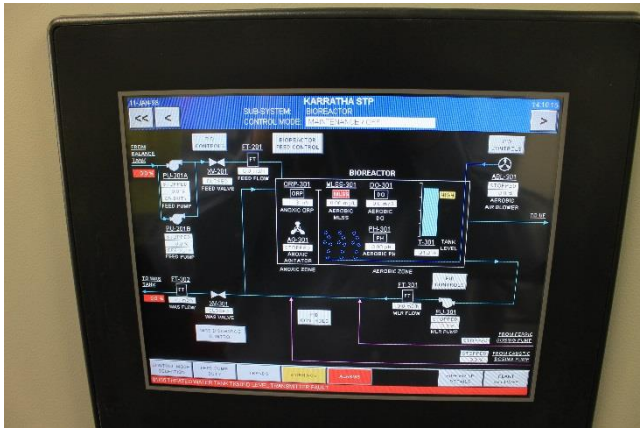

Projects Experience

Project	Wheatstone LNG Project
Location	Onslow, WA
Date	2012
Scope	Design & construct, installation & commissioning
Capacity	200 m^3/day
Influent	Domestic Strength Sewage
Treated Water	Class A for risk category medium reuse
Features	40’ Containerised plant 2 x 50% UF trains Fully automated plant, including membrane cleaning systems Ultra high quality effluent External pressurised UF membranes ClearAccess™ Remote Monitoring & Control MAK Standard (Data Sheet Product)